

Earth Observation data exploitation in Urban Surface Modelling: The Urban Energy Balance response to a suburban park development.

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1. Supplementary Material

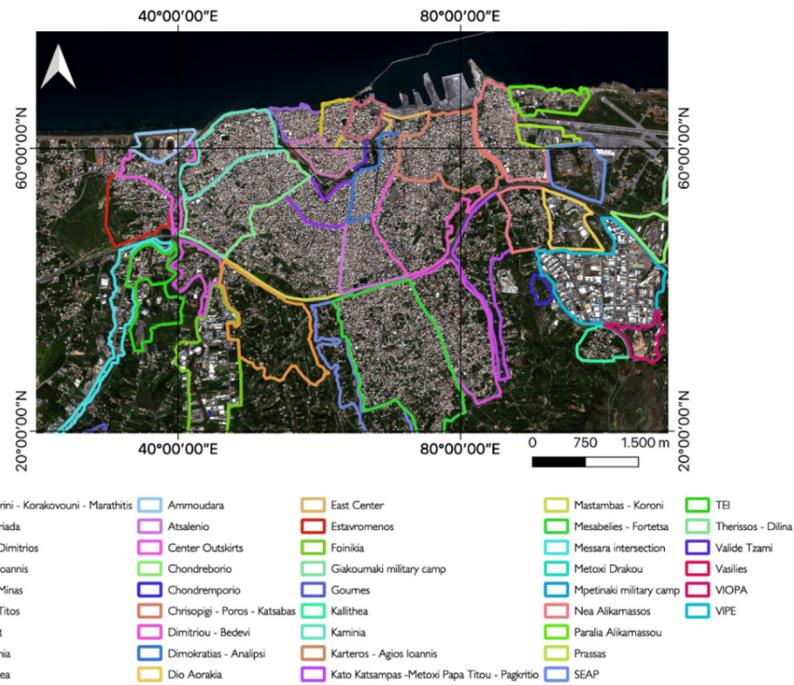


Figure S1. Urban Units of Heraklion municipality. Baseline image: WorldView-2 pansharpened imagery 19/03/20.

Table S1. WorldView-2 Sensor wavelengths per band [1].

Band Name	Central Wavelength (nm)	Minimum Lower Band Edge (nm)	Maximum Upper Band Edge (mm)
Panchromatic	625	447	808
Coastal	427	396	458
Blue	478	442	515
Green	546	506	586
Yellow	608	584	632
Red	659	630	690
Red Edge	724	699	749
NIR 1	831	765	901
NIR 2	908	856	1043

Table S2. Sentinel-2 bands [2].

Band Name	Central Wavelength (nm)	Bandwidth (nm)	Spatial Resolution (m)
B1	443	20	60
B2	490	65	10
B3	560	35	10
B4	665	30	10
B5	705	15	20
B6	740	15	20
B7	783	20	20
B8	842	115	10
B8a	865	20	20
B9	945	20	60
B10	1380	30	60
B11	1610	90	20
B12	2190	180	20

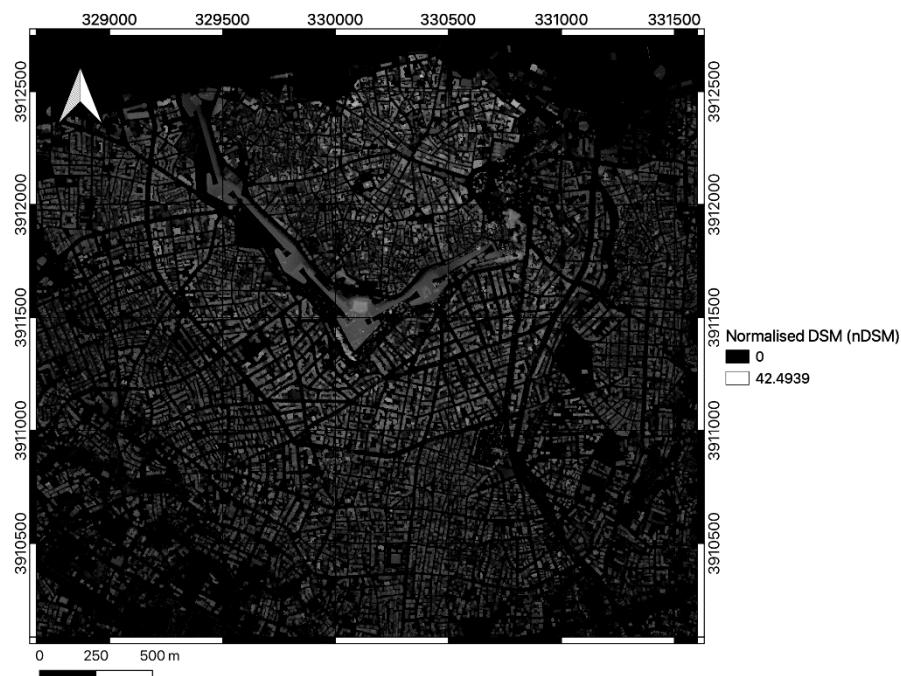


Figure S2. Normalized DSM for the city of Heraklion (1×1 m).

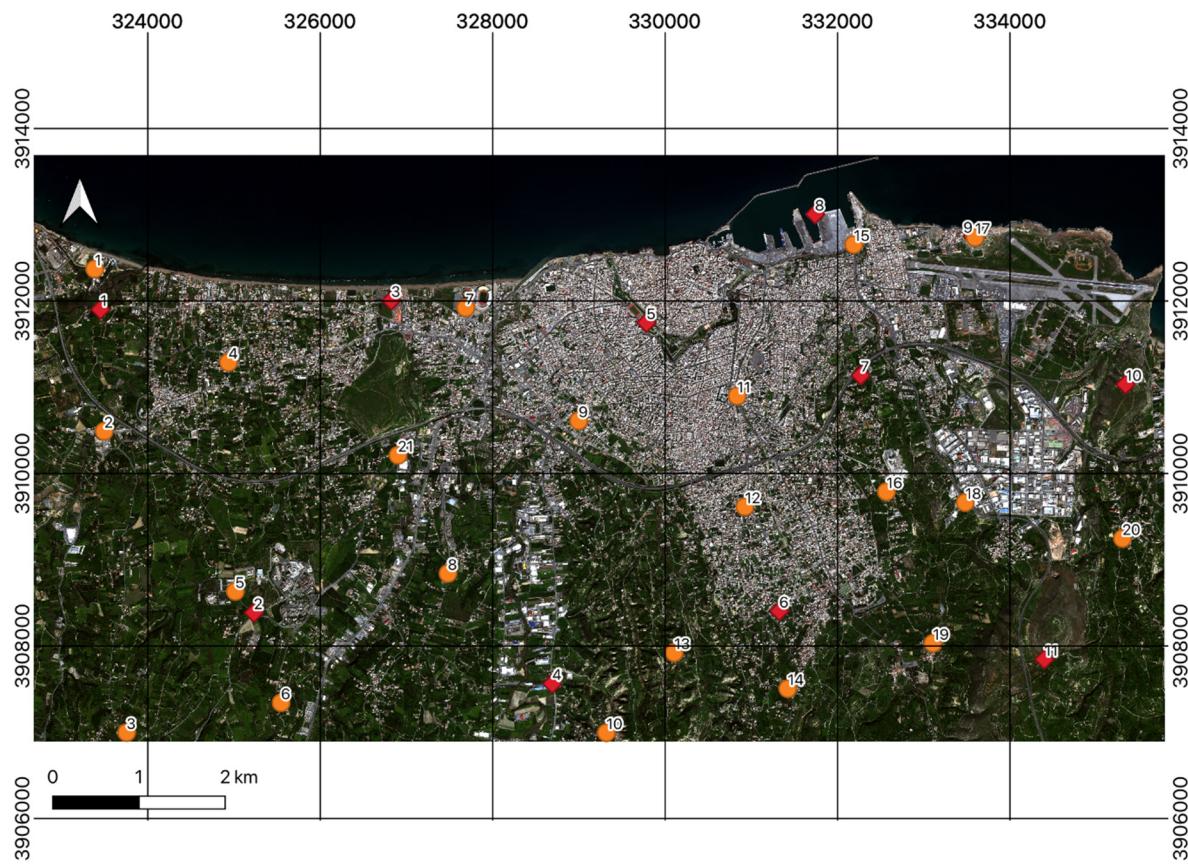


Figure S3. Ground Control Points (red circle) and Check Points (orange circle) used for the registration process and validation of the result.

Table S3. Confusion matrix for the validation of the 5-class surface cover map shown in Figure 7 (Overall Accuracy: 92.6 %).

	Reference Class					Sum
	Paved	Buildings	Vegetation	Bare Soil	Water	
Paved	82	8	3	7	0	100
Buildings	1	98	1	0	0	100
Vegetation	3	2	90	5	0	100
Bare Soil	6	0	1	93	0	100
Water	0	0	0	0	100	100

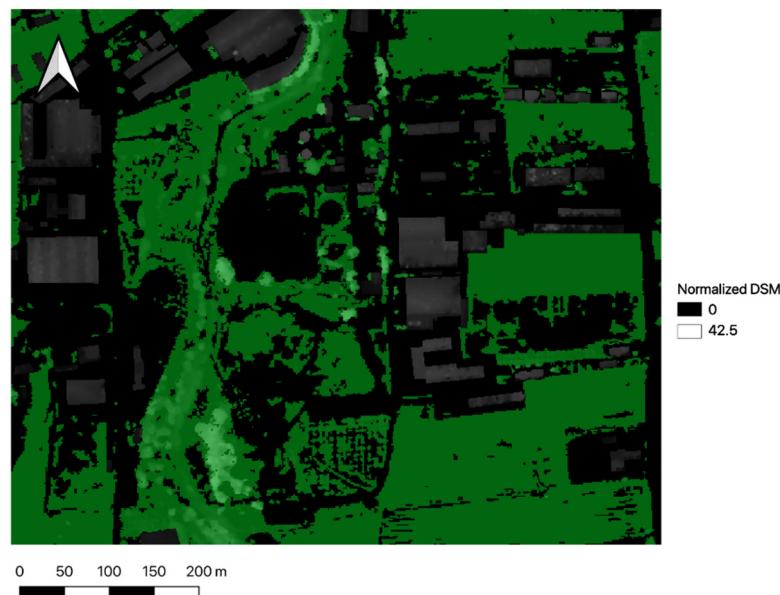


Figure S4. Overlay of vegetation layer and nDSM to differentiate between low (<2m) and high (>2m) vegetation.

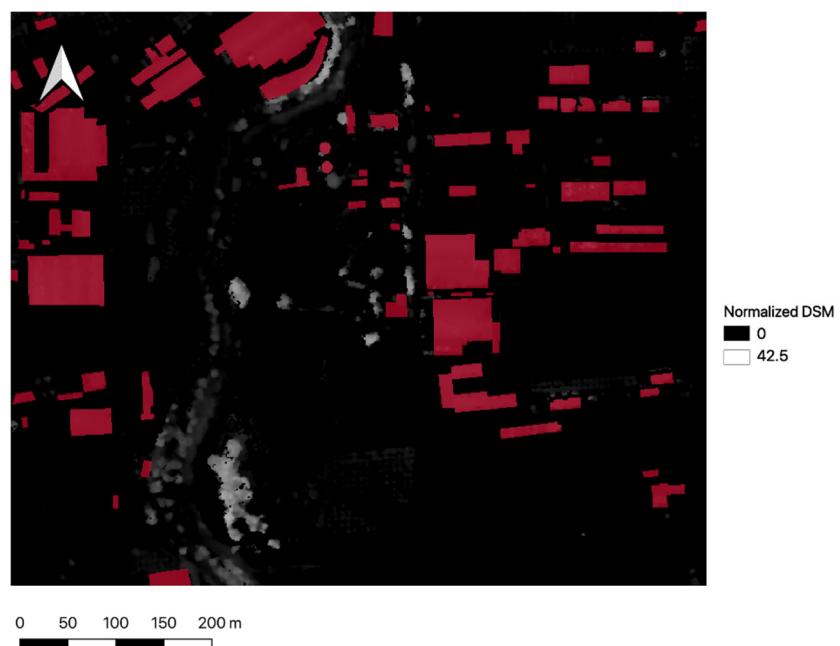


Figure S5. Overlay of nDSM and the Buildings layer.

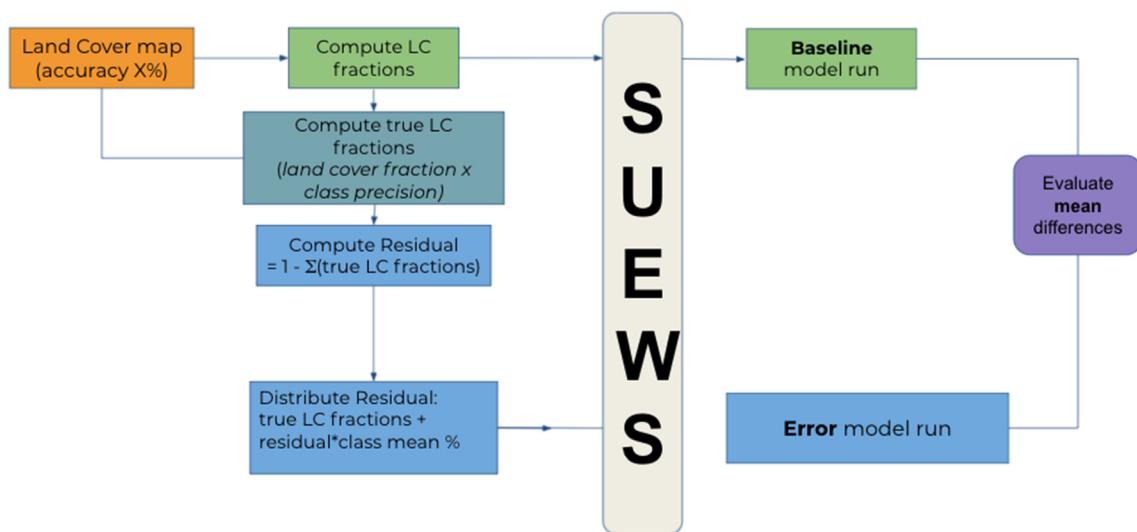


Figure S6. Workflow followed to compute errors in flux outputs introduced from the land cover map accuracy.

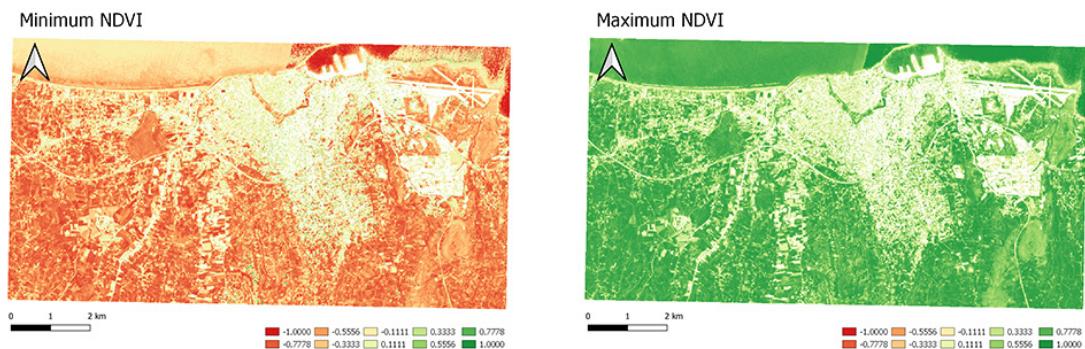


Figure S7. Annual minimum and maximum NDVI values extracted from monthly composites of Sentinel-2 images for 2020.

Table S4. Confusion matrix and class-wise precision of the final surface cover map.

	Reference Class							Sum	Precision
	Paved	Buildings	Evergreen	Deciduous	Grass	Bare Soil	Water		
Paved	82	8	0	0	3	7	0	100	0.82
Buildings	1	98	0	0	1	0	0	100	0.98
Evergreen	0	0	86	4	10	0	0	100	0.86
Deciduous	0	0	9	78	13	0	0	100	0.78
Grass	3	2	0	0	90	5	0	100	0.90
Bare Soil	6	0	0	0	1	93	0	100	0.93
Water	0	0	0	0	0	0	100	100	1.00

Table S5. Current Surface cover percentages and bulk albedo values of grid cells subject to changes in land cover based on the development plan. Imminent changes are shown in the parentheses.

Grid Cell	Paved	Buildings	Evergreen Trees	Deciduous Trees	Grass	Bare Soil	Bulk Albedo
3	43.8 (+1.1) (-)	23.9 (-0.3)	4.6 (-0.3)	0.0 (+3.4)	20.4 (-3.3)	7.3 (-0.9)	0.13 (-0.01)
4	44.3 (+3.8) (-)	17.7 (-0.2)	1.4 (-0.2)	0.0 (+3.7)	25.7 (-5.2)	10.9 (-2.1)	0.13 (-)
5	21.2 (-0.6)	12.5 (-)	2.6 (-)	0.0 (+0.6)	58.5 (+0.4)	5.2 (-0.4)	0.15 (-)
8	32.7 (-0.2)	28.9 (-)	5.1 (-)	0.0 (+0.4)	21.2 (-0.1)	12.1 (-0.1)	0.13 (-)
9	30.3 (+8.9) (-)	4.1 (+0.7)	0.9 (+0.7)	0.0 (+4.3)	54.4 (-8.9)	10.3 (-5.5)	0.15 (-0.01)
10	23.2 (+3.8) (-)	0.8 (+2.6)	2.4 (+2.6)	0.0 (+2.7)	45.7 (+2.8)	27.9 (-11.9)	0.16 (-0.01)
13	33.7 (-0.1)	24.4 (-)	11.2 (-0.3)	0.0 (+0.7)	25.1 (-0.2)	5.6 (-0.1)	0.13 (-)

Table S6. Morphometric parameters for buildings of grid cells subject to changes in land cover.

Grid Cell	Mean Building Height (m)	Plan Area Index	Frontal Area Index	Roughness Length (m)	Zero-plane displacement (m)
3	9.476	0.242	0.157	0.948	6.633
4	8.205	0.180	0.071	0.821	5.744
5	9.466	0.126	0.089	0.947	6.626
8	8.263	0.293	0.286	0.826	5.784
9	8.538	0.041	0.005	0.854	5.976
10	7.000	0.008	0.003	0.700	4.900
13	8.204	0.245	0.157	0.820	5.743

Table S7. Morphometric parameters for trees of grid cells subject to changes in land cover. Changes based on the development plan are shown in the parentheses.

Grid Cell	Mean Vegetation Height (m)	Plan Area Index	Frontal Area Index	Roughness Length (m)	Zero-plane displacement (m)
3	4.307 (-0.538)	0.050 (+ 0.036)	0.062 (+0.041)	0.431 (-0.054)	3.015 (-0.376)
4	4.271 (-0.963)	0.012 (+ 0.041)	0.018 (+0.046)	0.427 (-0.096)	2.989 (-0.673)
5	5.030 (-0.443)	0.028 (+ 0.007)	0.012 (-)	0.503 (-0.044)	3.521 (-0.310)
8	5.204 (-0.195)	0.047 (+0.004)	0.074 (-)	0.520 (-0.019)	3.643 (-0.136)
9	2.747 (+0.211)	0.010 (+ 0.051)	0.003 (+0.072)	0.275 (+0.021)	1.923 (+0.148)
10	2.618 (+0.263)	0.024 (+ 0.054)	0.002 (+0.050)	0.262 (+0.026)	1.833 (+0.183)
13	3.462 (+0.032)	0.113 (+0.004)	0.061 (+0.003)	0.346 (+0.003)	2.423 (+0.022)

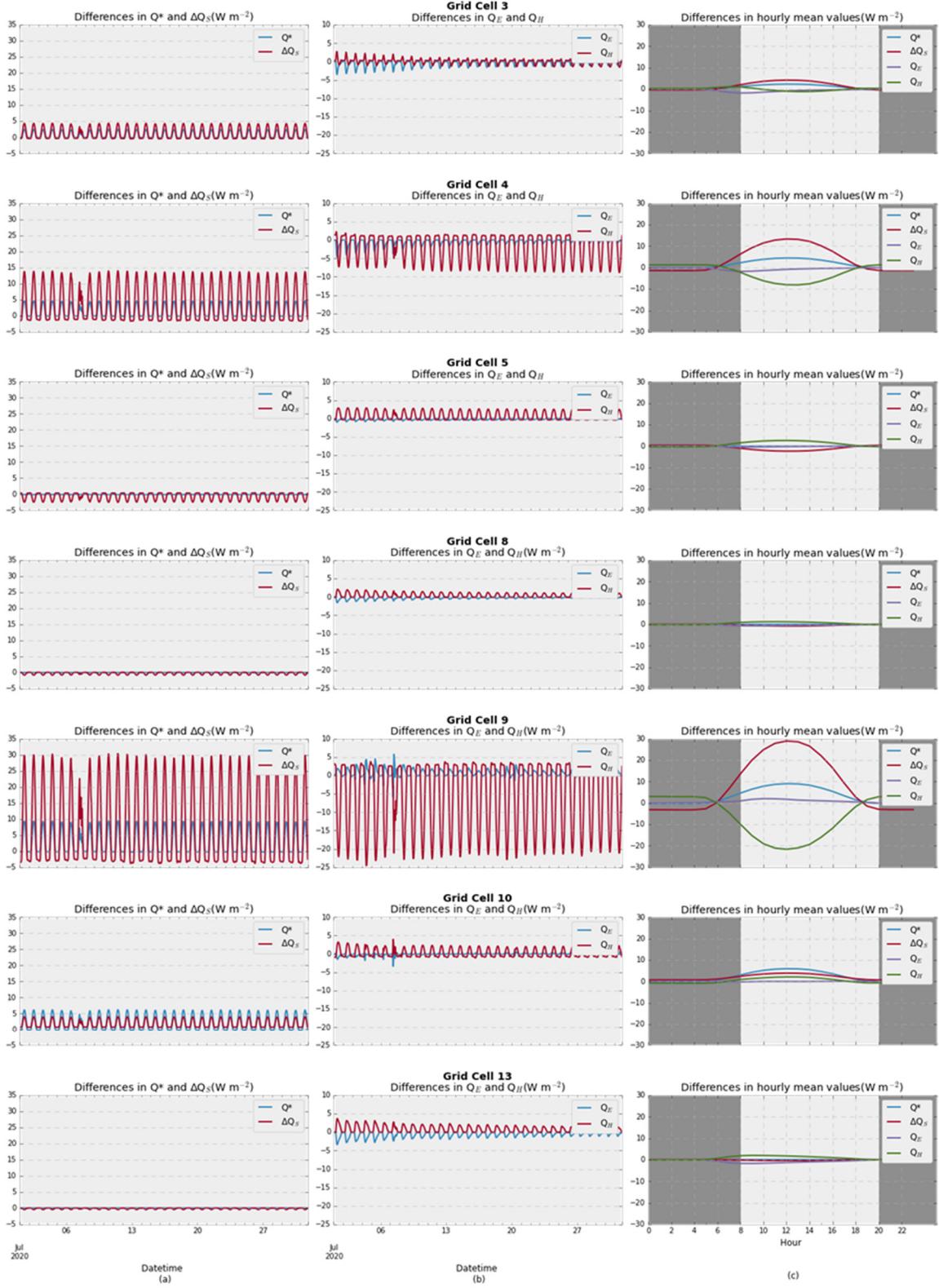


Figure S8. Differences in raw values (columns a and b) and differences in hourly means (column c) of Q^* , ΔQ_S , Q_E and Q_H for the future – baseline model run outputs per grid cell. In column c, daytime and nighttime hours are shown in light grey and dark grey background respectively.

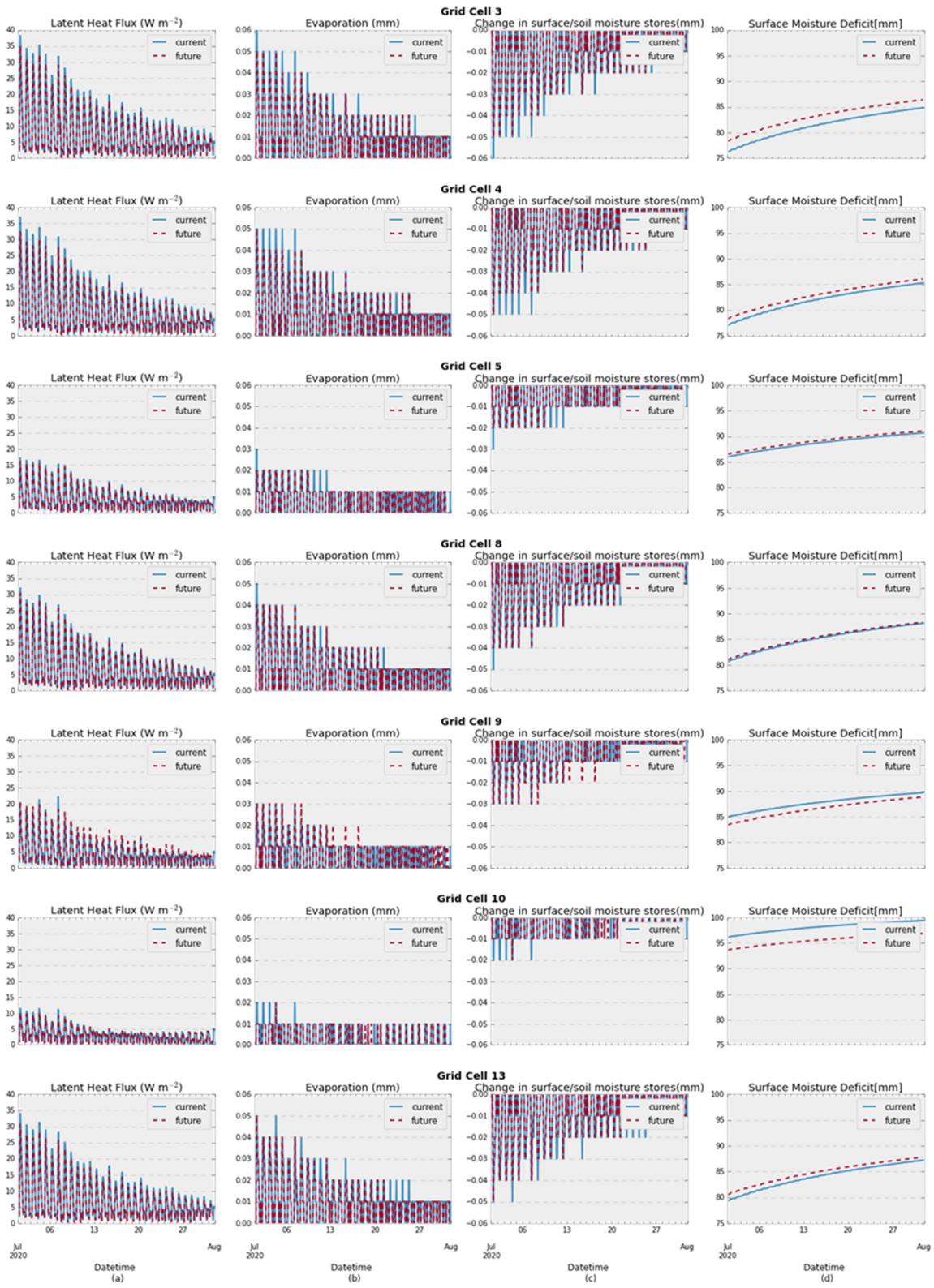


Figure S9. Latent Heat Flux (a), Evaporation (b), Total change in soil and surface moisture storage (c) and Soil Moisture Deficit (SMD) (d) model outputs for the baseline and future model run.

Table S8. Monthly maximum values per grid for the baseline and future development model runs.

	Cell 3		Cell 4		Cell 5		Cell 8		Cell 9		Cell 10		Cell 13	
	cur	fut	cur	fut	cur	fut	cur	fut	cur	fut	cur	fut	cur	fut
Q*	770.8	773.3	765.34	770.00	746.2	746.1	765.8	765.9	746.9	756.3	740.8	747.0	768.5	768.5
QH	387.3	385.8	392.17	383.34	481.6	484.2	409.6	410.5	462.4	440.1	474.6	476.8	422.4	423.4
QE	38.3	34.9	37.02	32.37	17.2	16.2	32.0	30.5	22.2	20.9	11.6	10.4	34.1	30.7
ΔQS	406.1	410.5	395.84	409.83	289.5	287.0	379.0	378.2	309.7	340.0	293.4	297.4	368.1	367.6

References

1. ESA. WorldView-2. Available online: <https://earth.esa.int/web/eoportal/satellite-missions/v-w-x-y-z/worldview-2> (accessed on 7 June 2021).
2. ESA. Sentinel-2. Available online: <https://earth.esa.int/web/eoportal/satellite-missions/c-missions/copernicus-sentinel-2> (accessed on 12 January 2021).